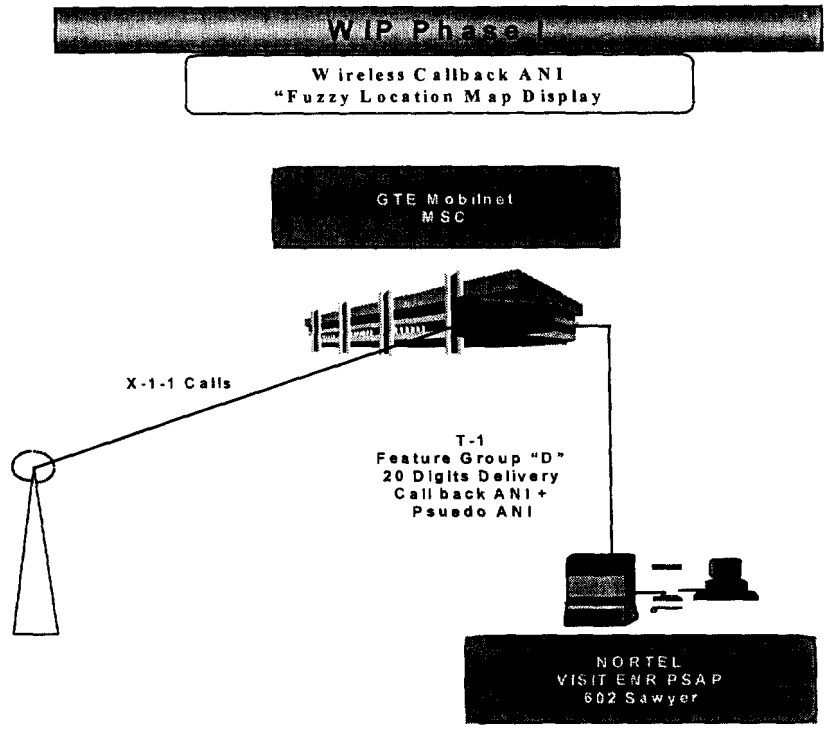


PHASE ONE PROJECT VARIABLES:

Early on during the WIP project, the team identified variables to be explored during the various phases of the project. The team discussed the nature of each variable in terms of whether technology aspects relative to each were already in existence, whether new methods were currently under development, or where new technology adaptation would be required. These variables included location technology, transport of data, network intelligence, PSAP CPE, dynamic call routing and data management, and data format. Each are discussed as components in the Service Level section presented previously in this document. As applicable to Phase I, each variable is discussed below.

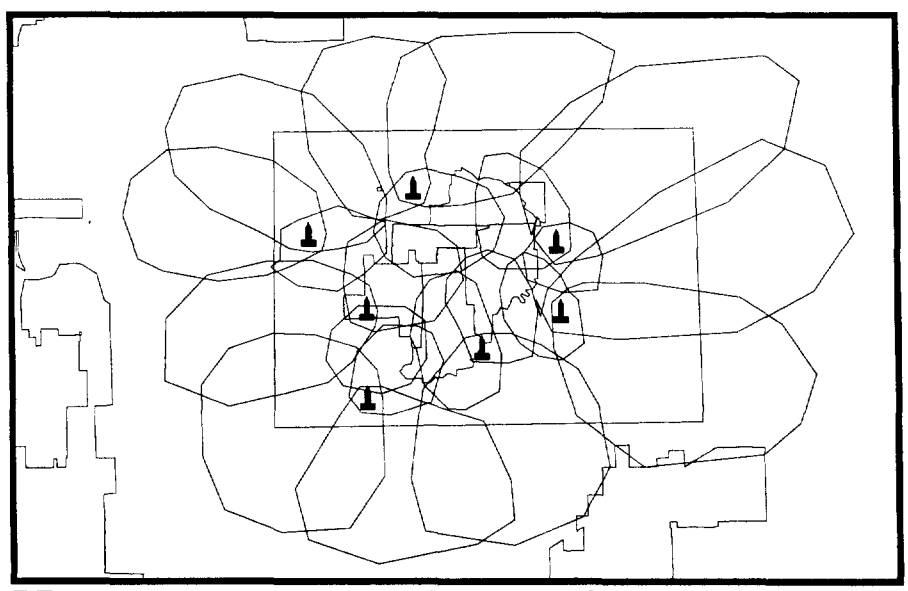
Network

Southwestern Bell provided a clear channel T-1 (1.544 Mbps) circuit between Greater Harris County 9-1-1 Emergency Network Offices and the GTE switch in Houston. The circuit was built from GHC to a node on the GTE Network. GTE extended the circuit into their Braxton MSC, also located in Houston

Location Technology:

The level of location identification accomplished in Phase One of the WIP was cell antenna and sector identification. An RF coverage map for the test cell sites was created by extrapolation of data from paper maps supplied by the GTE Mobilnet (wireless carrier) RF engineering groups. Coverage areas were drawn as rough polygons onto the base map of the pilot area. Cell tower and ESN overlays created contained data tables describing appropriate attribution for each coverage layer.

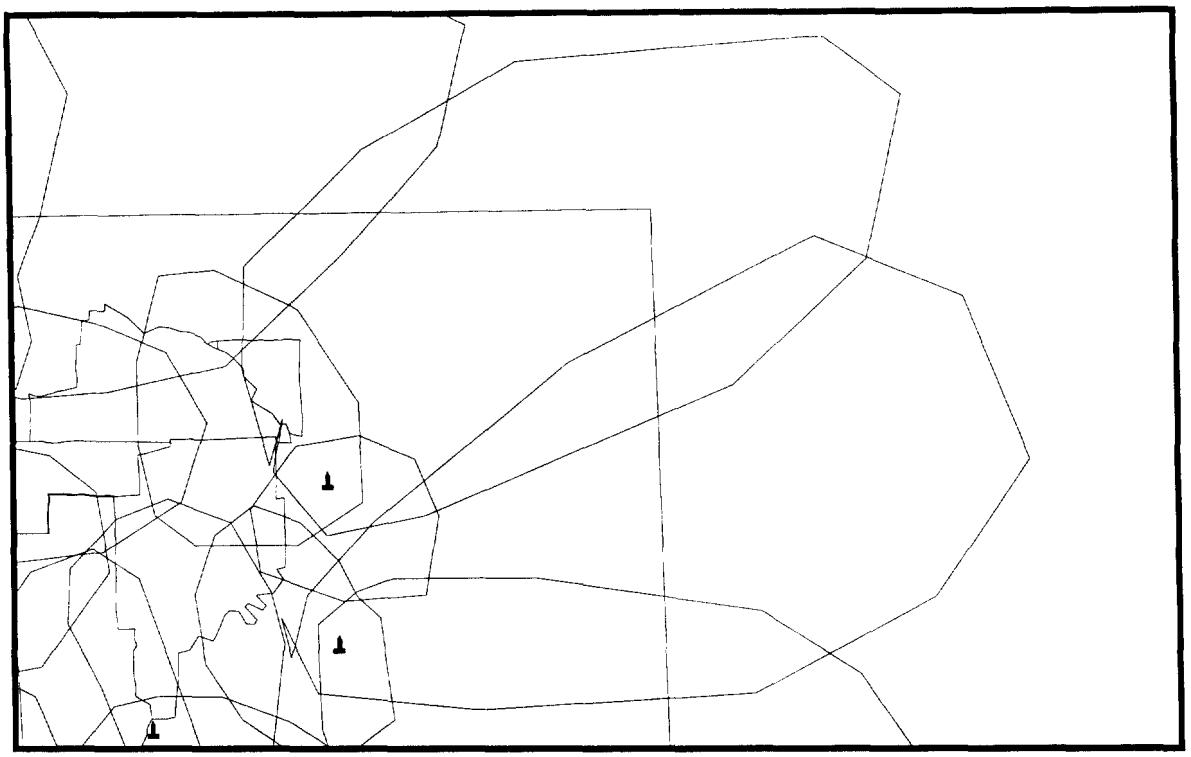
Location technology identified for Phase I is described as "fuzzy" because it does not pinpoint the locational source of the call. Rather, it allows identification of a radio-frequency coverage area for the cellular antenna on which the call is received. Signals from within a specific area are generally sent to one antenna for relay into the switched network. To simulate the location of a cellular call to the 9-1-1 network, a map was created identifying the radio frequency coverage area of each of the antennas located within the test area. The map itself resembled a cluster of ovals grouped around the cell tower icons placed on the map.



RF coverage map and tower locations of GTE Mobilnet antennas employed for Phase I

Data related to each of the cell towers was created for this test by assigning pseudo ANI numbers for each antenna, or cellular tower face, in the test area. The pseudo ANI was then used as a static piece of data that would be related to the specific polygon on the map representing the radio frequency coverage area for that antenna.

ID	TOWER NUMBER	TOWER NAME	FACE
1	067	Bering	B
2	067	Bering	A
3	067	Bering	G
4	045	Wirt	B
5	045	Wirt	A
6	045	Wirt	G
7	065	Voss	B
8	065	Voss	A
9	065	Voss	G
10	028	Westheimer	A
11	028	Westheimer	G
12	028	Westheimer	B
13	044	Briarforest	B
14	044	Briarforest	A
15	044	Briarforest	G
16	027	Town & Country	B
17	027	Town & Country	A
18	027	Town & Country	G
19	043	Gessner	B
20	043	Gessner	G
21	043	Gessner	A



Each tower usually has three antennas facing in different directions from the tower site. Each antenna face receives signals from within a general coverage area and the shape and extent of coverage for each face varies based on receiver strength, topography, structural interference (such as buildings) and proximity to other receivers.

CPE

Call data was received at the VISIT ENR desktop, an integrated workstation, for receipt of ANI and conversion of location data into appropriate displays. The call was processed by the NORTEL Meridian 1 PBX containing the caller's ten (10) digit mobile identification number (MIN) and the ten (10) digit pseudo ANI tower location in the Dialed Number Inward System (DNIS). These two numbers are presented to the call taker on the phone instrument LCD and passed to NORTEL's VISIT ENR 911 application. Computer Telephony Integration (CTI) technology was used to obtain these numbers from the PBX and pass the pseudo ANI to the COMBIX GIS using DDE for application processing.

The pseudo ANI currently uses the following format:

BYTE	DESCRIPTION	DATA
1-5	Constant	"71390"
6-7	MTSO	--
8-9	Cell Tower	00-99
10	Facing	"A" Alpha "B" Beta "G" Gamma

An SQL join was performed using the Emergency Service Number (ESN) table and the cell tower table with the resulting intersection highlighted on the map. This gave the dispatcher a visual representation of the generalized geographic location of the caller, the ESN(s) assigned for the identified geographic area, the caller's mobile identification number (MIN) for call back purposes, and the caller's Address Location Information (ALI). The call taker can maneuver around the map using MapInfo tools as questions concerning location are answered. These include street names and intersections, landmarks, bodies of water and other useful pieces of information that one would choose to integrate into this location technology. Once a satisfactory location of the calling party is determined, a click of the mouse or a pull-down menu sends the ESN information to the VISIT ENR and a tandem transfer is initiated to the proper jurisdiction (manual transfer).

ID	ESN	ESN NAME
0	088	Spring Valley
0	089	Hilshire
0	057	Hunters Creek
0	098	Piney Point
0	098	Bunker Hill
0	021	Houston

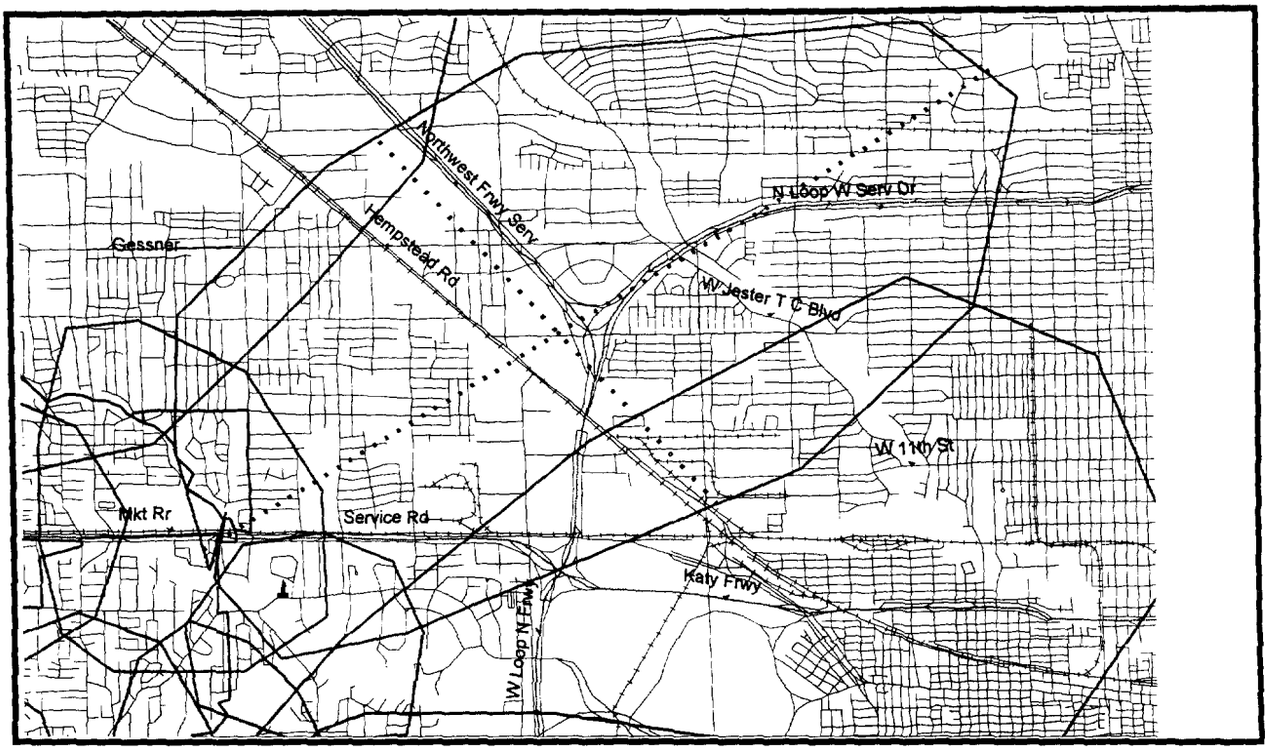
Dynamic Data Management:

For Phase I, data management was relatively static. The map display provided the call taker with a graphic image of the general geographic area the call is generated from, which we refer to as "fuzzy location." Graphic data gives the viewer the sensation that the data is dynamic in nature, which is a cognitive function. By contrast, the textual data display drives other mental processes still required to complete the dispatch of the call.

Data used for the graphic display is nearly identical to that used for the textual display. In effect, the map itself is a graphic image of the tabular data. To achieve fuzzy location, the graphic display can be very general in nature and does not require spatial accuracy. In other words, the graphic does not rely on accurate placement of specific nodes at specific (x,y) coordinate locations. It does require relative accuracy in the placement of symbols, lines and labels representing streets, landmarks, boundaries and other physical features. Relative accuracy of the placement of map features allows the viewer to quickly recognize the physical location of the call within the community. Data on the graphic image must be complete, up to date, and programmed to display at an appropriate scale for the call taker to successfully handle the incident. It should be pointed out that the total area encompassed by the RF coverage can be quite large. For example, the shaded area in the following figure is approximately three miles on a north/south axis and 2 miles in east/west extent (or close to six square miles in area coverage). Fuzzy location, therefore, is nearly meaningless in areas where the tower coverage radius is very large (i.e., 7.5 miles from tower in 360° sphere).

Data and graphic objects were created to provide an appropriate base map for the display of the fuzzy location. Cell towers were identified by identification number, site name, and cellular carrier name; cell tower faces or sectors were further identified by test area identification number, cell tower number, site name, and directional face; emergency service area numbers were assigned to the various communities within the test area.

Corresponding graphic objects were created along with each of the above data sets. In a graphic environment, spatial relationships can be established by the viewer intuitively as each layer of display overlies the previous layer. The display presented to the viewer may contain an unlimited number of data sets, and the programmer must determine which of those data sets is necessary to the task at hand.



The map above includes an RF coverage area with streets, ESN boundaries, and selected feature labels. The area of coverage has a NE/SW axis of approximately 5.5 miles by 3.5 miles on the NW/SE axis.

Call Routing:

Utilizing current schemes, call routing in Phase I was not dynamic, but rather static and based upon the coverage area of each cell sector. Pseudo ANI records contained ESN's that associated pseudo ANI's with appropriate PSAP destinations. Actual ESN's used for system selective routing were also employed in the test to route calls to the Beta A and Beta B answering points.

Emergency service area boundaries can be used to determine the routing of cellular calls based upon the location of the cellular tower. While this routing scheme is not dynamic, it has been used in 9-1-1 networks to affect the routing of calls from cell towers to multiple answering points. Building the routing scheme for cellular traffic requires subjective predetermination on where calls would be most appropriately routed. The decision process must involve recognition of the RF coverage area of the cell antenna, as described in the Location Determination variable and knowledge of local circumstances that have bearing on the routing of the call from within the RF coverage area, such as land uses and traffic patterns.

Pseudo ANI is defined as a number assigned by the wireless network system to a 9-1-1 call from a wireless device. The Pseudo ANI is generally used to identify information unique to the specific 9-1-1 call, such as cell site or cell sector of call origination. This number is typically not valid for use in reconnecting with a calling party if the original call is terminated.

As an example of the routing of cellular calls through the public 9-1-1 network, we review the solution enacted in 1987, and practiced for ten years in Tarrant County, Texas. Tarrant County 9-1-1 District identified fifteen public safety answering points for selective routing of cellular call traffic. Emergency service numbers were established for each of the fifteen PSAPs which provided special instructions on the screen for call takers. These instructions indicated that the call was from a MOBL phone, that the call taker should "Verify Location," "Request Caller's Phone Number," and use either seven or four digit numbers to transfer the call to another agency. Extensive training was also developed to instruct call takers on appropriate techniques for handling cellular calls.

The data developed to affect the selective routing required that each call antenna be identified with a tower identification number, pseudo ANI, ESN, and location description. Vendor identification was also made for research purposes in the event of questionable routing or call delivery. Tarrant County staff assigned routing codes based on subjective knowledge of the service area, information provided by cellular carriers, and PSAP willingness and ability to accept cellular call traffic.

Cellular carriers were assigned pseudo ANI to be programmed at each antenna switch. On receipt of the 9-1-1 number sequence, the antenna switch translated the 9-1-1 called number to the pseudo ANI for that antenna and performed call forwarding of the pseudo ANI to the 9-1-1 network tandem. The tandem then routed the call to the predetermined PSAP. Using the pseudo ANI, the PSAP ANI controller queried the 9-1-1 Data Base Management system for data to be delivered as ALI back to the PSAP.

Shortcomings of this solution include the following:

- Call-back ANI of the cellular caller is not delivered.
- Pseudo ANI is a dialable number, which leaves the 9-1-1 network open to questionable calls. In some instances, numbers have been temporarily misprogrammed, causing erroneous routing from outside of the service area.
- Location information provided is "fuzzy", and includes the address or intersection of the tower site, but does not include a graphic display of the cell tower coverage area. Specific Location is not delivered to the PSAP.
- Data is only displayed as Textual ALI on a standard ALI Display screen.

In some areas of the country, cellular calls are routed to a single PSAP regardless of where they are generated from within the geographic coverage area. The advantages of this scheme are that call handling is standardized by the single agency, but depending upon how the overall data plan and assignment of pseudo ANI is developed and implemented, little or no information is delivered regarding call locations.

Data Format:

The data format for Phase I of the Wireless Integration Project was created by agreement between Team Members specifically to accomplish the trial. This required creation of a naming convention for the pseudo number for the test. The purpose of the pseudo number is to indicate the location where a cellular call is originating, or in this scenario, the identification of a specific cellular antenna face. The following format was employed:

713-90e-cccf

Where	713	= area code (in test area this is always "713")
	90	= first two digits of NXX (in trial this is always "90")
	e	= ecp (Mobile Telephone Switching Office)
	ccc	= cell site number (can be as many as three digits)
	f	= face/sector of cell site (alpha=1,beta=2,gamma=3, omni=0)

Therefore 713-904-0221

Translates to

713	= area code
90	= first digits of NXX
4	= Westpark (mobile switch)
022	= cell site 22 (Gessner)
1	= face/sector 1 (alpha)

Other data was not retrieved in Phase I of the trial. Options do exist for producing additional data, but in this portion of the trial any ALI detail produced was generated at the desktop through use of the pseudo ANI and the relationship of data within that stream to the map base.

Desktop:

Using NORTEL's VISIT ENR platform, the windows based application, MapInfo, was added to the Greater Harris County PSAP workstation desktop. Data from the test area cell towers was integrated with objects in the graphic environment (polygons representing RF coverage areas for each cell antenna). This data relationship was used to generate a map area associated with a specific cell face when the call was presented to the PSAP.

PHASE I IMPLICATIONS:

Private Network Viability

The WIP demonstration shows that Phase I implementation can be accomplished quickly using a privatized ISDN based network . Greater Harris County's network has been developed with future directions in mind and the integrated workstation desktop has already been deployed in anticipation of meeting those future needs. Modifications required to accomplish Phase I included trunking between the cellular carrier and the GHC switch, map base development to include cell site information and radio frequency coverage for each cell face, data format creation, data development, and software modification to display calling party information on the desktop. In the small area used for Phase I, actual preparation, software modifications, data development and mapping was accomplished in less than two months time.

One of the major shortcomings of the solution affected in Phase I of the WIP trial is that the area identified as the cell caller's "fuzzy" location is so large, relative to a point specific location identified in the traditional ALI display, that the location information is essentially useless for actual dispatch. The call attendant is definitely required to query the caller extensively to get a fix on the location where assistance is needed. The fuzzy location, presented in graphic form, is an enhancement to previous use of text only to identify tower site and antenna face, as described for Tarrant County's solution. On the other hand, the benefit to the PSAP is that they now receive the caller's ANI, or a number that can be called back in the event that the connection is somehow broken. The presence of the pseudo ANI is also useful for default routing of the call to a predetermined destination in the event that caller ANI cannot be delivered. In this test, roaming wireless callers were not identified, and thus the pseudo ANI would be required to deliver roamer calls to the PSAP.

Additionally, transfer of calls to any PSAP not on the privatized network through existing selective routing tandems would not be easily accomplished. Rather extensive modifications to the network signaling would also be unlikely.

Public Network Modifications

In order to deploy phase one of the FCC's mandate, the ability to pass twenty digits indicating callback ANI and pseudo ANI are of prime necessity. Most local exchange carriers cannot, however, accommodate this series of digits and utilize the information in existing selective routing tandems without substantial software modifications.

This does not preclude the use of third party applications between the mobile switch and the 9-1-1 tandem. Some solutions are now marketed to the 9-1-1 community that account for the embedded architecture and can accommodate existing PSAP premise equipment. SCC Communications Corp., a participant in the Texas WIP, is a vendor of such solutions.

Data and Map Base Requirements

Agreement was reached on the trial format for Pseudo ANI used in Phase I. The cellular carrier provided information relative to all of the cell sites in the test area. The cellular carrier also provided paper maps indicating RF coverage for each of the sites. From this information, Team members built a format for the pseudo ANI delivery which included the local area code, first two digits of NXX, mobile switching office identifier, cell site number and face or sector of the cell site. The information provided by the cellular carrier was then used to build related data tables and maps to enable the appropriate display of information at the desktop.

Maps were loaded directly onto the desktop in this trial. No effort was made to correct map base information or to update the maps with missing streets or address ranges. Application of fuzzy location does not require that map attribute detail be exact. It provides a frame of reference for the call attendant to engage in the verbal query process to pinpoint the caller's location. The addition of landmarks to the base map would have been a useful form of reference to provide to the call attendant to aid in the query process.

MapInfo, or any other map viewing software, can be installed in a Window's based environment. Maps available off-the-shelf, derived from US Census TIGER files, are adequate for determination of "fuzzy" location. Application of these maps should be considered as a short term solution, however, and plans for attribute update must be put in place to insure future updates take place. Maps represent snapshots in time,

similar to photographs. The urban environment is an ever changing one where new streets are built, boundaries change, and land use and land marks change over time. It is important to maintain the currency of the base map, even if the Census TIGER file is chosen for use.

Another consideration with regard to the RF coverage of cell site antennas is that the cellular carrier is likely to alter those coverage areas as their network is modified to meet the traffic requirements of their customers. Such modifications would need to be monitored and added to the base map present at the PSAP desktop. If multiple installations are made of the base map, then all installations must be updated whenever the map is updated.

Washington State Phase I Demonstration

Documentation of trials in Washington State is included, with permission, in this report. The Washington State trial employed the public telephone network with required data transmission alterations and PSAP CPE modifications, to deliver ten digit call-back ANI to the PSAP. This activity, which coincides with the FCC's Phase I description, is documented as a parallel to the WIP Project's first phase in this report. The activity was conducted separately from either of the other two phases. The critical importance of the Washington trials comes from the reality of extensive infrastructure within the State of Texas, and elsewhere, that may be employed with some modifications for compliance with Phase I as mandated by the FCC within the limited timeframe. WIP Phases I and II were largely reliant on the use of a privately maintained telecommunications network belonging to the Greater Harris County 9-1-1 Network. The Washington trial demonstrates a solution within a commonly found 9-1-1 network environment, rather than in the specialized network found in Harris County, moving the test out of the controlled setting and into the public telephone network using a working DMS100 switch and modified desktop CPE. Clark County's Implementation plan is included on the following pages.

U S WEST Communications

E911 Clark County, Washington

CellTrace Technical Trial

Project Description

The Enhanced 9-1-1 (E9-1-1) wireless 10-digit Automatic Number Identification (ANI) project (CellTrace service) was designed to test the feasibility of routing a wireless (cellular) dialed 9-1-1 call based on the geographic coverage of a wireless antenna site (cell site) to the appropriate Public Safety Answering Point (PSAP). In addition, upon completing the call to the PSAP, the cell site location and caller's Mobile Directory number (MDN) will be displayed on the PSAP's Automatic Location Identification (ALI) display device.

Wireless services currently are not capable of determining the location of the caller. Additionally, the CAMA signaling protocol used in the 911 network does not allow for identification of the caller's full 10-digit number and location.

The Proctor and Associates device, Cell-Link, enhances the capabilities of an E9-1-1 call to the PSAP by providing the caller's MDN and the location of the cell site from which the call originated. This additional information allows the PSAP personnel to determine the general location of the caller (based on the coverage of the cell site), and the caller's call back number.

Background

In 1994, the State of Washington passed legislation requiring cellular carriers to provide call back ANI for a 9-1-1 call. U S WEST Communications participated in a trial with McCaw Cellular and U S WEST NewVector Group to see if the actual caller's ANI could be passed from the cellular carrier over U S WEST Communications transport to the correct PSAP. This trial was completed in November 1994. After this trial, U S WEST Communications was only able to pass seven digits plus an NPA digit. This did not solve the problem of roamers or multiple NPAs within a LATA.

The E911 CellTrace trial purpose was to find a means of passing and capturing the full 10-digit ANI when a call to 9-1-1 is made. By using FGD signaling, the ten digits can be passed, but U S WEST Communications had no way of accepting ten digits into the 9-1-1 tandem system which uses CAMA signaling protocol and the PSAP equipment could not display a ten digit ANI in the ANI field. An RFI was issued to see if this limitation could be overcome. Proctor and Associates was chosen as the vendor to provide the interface device, Cell-Link.

Clark County

Clark County, Washington was chosen to be the trial site, which is supported today by the Clark Regional Communications Agency. The agency receives all 9-1-1 calls from the 310,000 citizens in the county, including the cities of Vancouver, Battle Ground, Camas, LaCenter, Ridgefield, Washougal and Yacolt, Washington. The agency answers an average of 1,000 calls daily. Approximately 13% of those calls are from cellular phones. Clark County's Director, Thera Bradshaw was an active participant during the development and testing phases of this trial.

Participants

The participants of the trial were U S WEST Communications, AT&T Wireless Communications, AirTouch Cellular, Clark County Regional 911 Center, Proctor and Associates, SCC Communications and Plant Equipment.

Strategy

This trialed approach sought to comply with Phase 1 of the FCC docket in an economic and efficient manner while minimizing the impacts on the E911 network, wireless carriers and PSAPS. This was accomplished by utilizing Cell-Link.

The Trial

The Technical Trial began September 9, 1996 and completed September 13, 1996. Test calls were made during the first twelve hours of the trial, then the system was opened to live wireless 911 calls for 72 hours.

The trial tested the routing of a wireless 9-1-1 call to a designated PSAP and the passing of the 10-digit ANI of the device placing the call for display at the call answering position. Each cell site or cell face forwarded information via a Mobile Switching Center (MSC) to the Cell-Link.

Call Flow

The Cell-Link device accepts the MSC's connection using Feature Group D (FGD) signaling which includes wireless caller's ten-digit ANI and the telephone number associated with the cell site which handled the 9-1-1 call. The Cell-Link device then re-formats the cell site telephone number and forwards the call to the Selective Routing Switch (SRS) using CAMA signaling format and also sends this modified information to the SCC SR/ALI platform. This allows the wireless call to be processed as a wireline call. The SCC SR/ALI platform holds the information sent by the Cell-Link and correlates the information at the time the receiving PSAP requests Automatic Location Identifications (ALI) when the call is delivered. The ALI message returned to the PSAP contained the full FGD information imbedded in the ALI message (see Screen Example).

Trial Termination

After completion of the trial, the Clark County PSAP was returned to their current environment, the cell-link was disconnected and the cellular calls came in as they did before the trial.

Next Steps

U S WEST Communications is in the process of prioritizing and planning the deployment of CellTrace. The Washington tariff has been filed and was in effect April 11, 1997.

PHASE II

Test Plan

Phase two of the WIP moved into the public switched network infrastructure. Houston Cellular's Erickson MSC was connected to Southwestern Bell's Lucent 5E 9-1-1 selective routing tandem via an SS7 link (Signaling System 7 protocol). Digital switching at the MSC, combined with digital transport and selective routing performed by a digital tandem, proved to be a truly efficient method for routing 2-1-1 calls. As discussed later in this document, the combination proved too efficient in some areas. Phase two was a great technical success and a learning experience for the team members, as well.

Three PSAP's were established to accept calls for this portion of the demonstration. As in phase one, two of the PSAP's were located in the Greater Harris County Lab facilities. The other PSAP was the Village Police Department, a live PSAP located within the test area. An additional call-taker workstation was installed for the demonstration to prevent interruption of normal dispatch operations.

The demonstration not only incorporated SS7/ISUP digital signaling between the Mobile Switch and the 9-1-1 selective routing tandem, but also utilized Primary Rate Interface (PRI) for call delivery to one of the PSAP's. The Beta A site, located in the GHC lab was designated for PRI call delivery and standard MF signaling was deployed for the Beta B and Village PD sites.

Premise equipment was again provided by NORTEL. All three PSAP's used VISIT ENR, with the Beta A site employing use of the GHC Meridian One Option 61 and the Village PD and Beta B sites using Meridian One Option 11's .

Phase II was to include transmission of the calling party's 10 digit mobile telephone number (ANI) all the way through the network to the call-taker's workstation. The team sought to use *existing* 9-1-1 tandem technology, digital networking, and location technology. Use of location determination technology allowed for calls to be routed to the appropriate PSAP based on the caller's location. Additionally, location data could be presented to pinpoint the caller's position on a map at the call-taker's workstation. Transmission of and selective routing on the caller's mobile directory number demonstrated the ability to accommodate subscribers that might be roaming outside their home system, and further demonstrated that modern existing selective routing tandems could be enhanced to provide a wider scope of service.

Technology used to determine the calling party's specific location, referred to by the Team as *Location Determination Technology* (LDT) was provided by TruePosition of Philadelphia, PA. The ability to pinpoint a caller and relay specific coordinates allowed for the use of other third party system components to dynamically route the call to an appropriate PSAP.

The process of determining the appropriate PSAP for a 9-1-1 call is very straightforward in the wireline environment. Phone numbers are static and can be loaded into a database of routing tables. Wireless is far more complex in that the caller's location is usually dynamic. The process of obtaining real-time location information for a 9-1-1 caller, determining which PSAP is appropriate for handling the call, feeding that routing information to a 9-1-1 selective routing tandem, and having that tandem deliver the call to the PSAP is referred to as dynamic call routing. This rather complex routine was accomplished by the team of TruePosition, SCC Communications and Southwestern Bell.

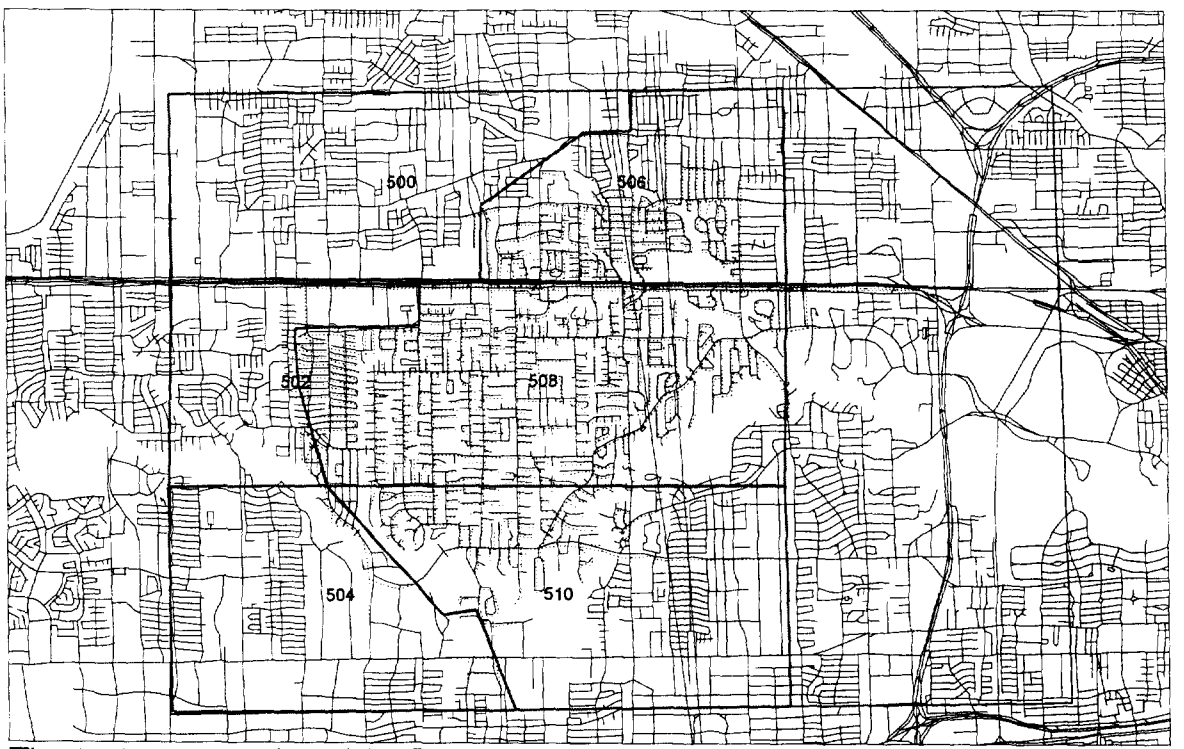
TruePosition's technology was designed to approximate a fix on the caller through TDOA technology. TDOA is Time Difference of Arrival technology, measuring radio signal arrival times at various radio receiver locations and mathematically comparing those signal arrival times to calculate a position. TDOA has been in navigational use for many years and continues to be perfected by advances in computer processing, digital signal processing and radio frequency technology.

TruePosition was chosen because of their ability to use the existing wireless telephone communications infrastructure and standard RF transmissions (phone calls) from the wireless telephone. No modifications were required of the subscriber's handset. TruePosition radio receivers were added to the aforementioned cell sites and each site was networked to location processing computers located in the GHC labs.

Real-time transmission of the approximated fix was relayed in the form of latitude and longitude to a software application provided by SCC. This application could plot the lat/long of the caller and translate that position to a standard routing scheme normally expected by a selective routing tandem. Selective routing tandems normally pass a telephone number to a tabular routing database and receive a routing code (ESN) in return. SCC replicated this process in a graphical format, referred to as a "point-in-polygon" routine. The selective router was unaware of any architectural changes and performed as normal.

The same location data that was provided to the router was stored in a dynamic ALI record and subsequently made available to the PSAP upon ALI lookup. This data was used to retrieve a map for display at the answering attendant's work station. This phase also provided for manual call transfer to an alternate PSAP or other PSTN destination.

PHASE II - Test Area Map



The test area employed for Phase II was smaller than that used for Phase I. For Phase I, the test area was wholly within the switching boundary of one mobile switching center of GTE Mobilnet. This area was primarily selected for jurisdictional, political and

mapping purposes. Unfortunately, the Phase II partner, Houston Cellular, divided the test area into two switch boundaries. Reduction in size of the Phase II test area was necessitated to accommodate the use of only one mobile switching center as requested by the cellular carrier.

The wedge shaped lines running through the right-center of the pilot area indicate approximate overlap in coverage area of Houston Cellular's two separate switching facilities. It should be noted that these boundaries are dynamic and change often, depending on carrier requirements.

Six ESN boundaries were created for the Phase II test area, numbered evenly from 500 to 510 on the map. For each of the three PSAPS receiving test calls, two ESN assignments were determined. The split allowed for each test site to receive calls from within the spatially corrected area on the map and from an area where spatial correction was not applied. Please note the dashed lines paralleling streets in the central portion of the map. These lines represent the original location of street segments prior to spatial correction.

Phase II Participation

Phase II of the Wireless Integration Project (WIP) incorporated the participation of Greater Harris County 9-1-1 Network, Houston Cellular, Southwestern Bell Communications (SBC), SCC Communications Corp., AGI/TruePosition, Lucent Technologies (formerly AT&T), NORTEL, GTE Telephone Operations, GTE Labs, and Tarrant County 9-1-1 as described below.

GREATER HARRIS COUNTY 9-1-1 NETWORK PARTICIPATION:

Greater Harris County 9-1-1 Network provided the concepts being proven to this project. They also provided technical project management, use of 9-1-1 PSAP facilities and equipment for carrying out the test, daily supervision of the test environment and schedule, technical staff and laboratory facilities. GHC secured participation agreements and had oversight of final technical documentation of the project.

WIRELESS CARRIER PARTICIPATION:

Wireless carriers participating provided resources and facilities including:

- use of not more than one mobile switching center;
- connectivity hardware/software (cards) for DS1 to mobile switch;
- up to but not more than ten (10) antenna towers, each of which may have as many as three cell site sectors (antenna faces);
- logistical and engineering support related to the deployment of the location technology;
- switching translations and transmission; and
- attendance at meetings for project coordination.

Houston Cellular delivered test calls from the carrier's mobile switching center (MSC) to the Southwestern Bell Communications selective routing 9-1-1 tandem via dedicated trunking (SS7) facilities provided by Southwestern Bell.

As in Phase One, calling party and called party numbers were delivered to the tandem. The called party number was again translated from the dialed digits to a unique pseudo number representing the cell sector delivering the call. The calling party number represented the caller's mobile directory number (MDN).

TRUEPOSITION PARTICIPATION:

In addition to the LDT results provided by TruePosition's equipment, Global Positioning Satellite (GPS) receiver units were used to determine actual location of the calling party reference sites to establish a confidence/accuracy level of the data compiled by the LDT provider. This same base line data was used to determine the level of accuracy in the map base deployed in the trial. An error factor of constant determination was applied to allow for base line data integrity and equitable evaluation criteria. Results documented illustrate the strengths and weaknesses of each component.

TruePosition provided resources and equipment to demonstrate location determination technology for the WIP trial. In this capacity, TruePosition provided:

- Installation of Signal Collection Systems at each cell site;
- Installation and management of the location processor hardware;
- Logistical support and coordination with wireless carrier;
- Timely plan to minimize resource requirements of wireless carrier;
- Liability release statements as required;
- Participation in a limited number of meetings for project coordination and documentation; and,
- Participation in the coordination of media and public relations

TruePosition's facilities provided coordinates of the calling party to SCC's Dynamic Call Routing software selective routing tandem via 56 Kbps data connections. The data delivered in real time included the calling party ANI, the approximated fix in latitude and longitude of the calling party, and a confidence level of the fix as measured in distance.

SCC'S PARTICIPATION:

SCC Communications Corporation provided their SR/ALI application on the Tandem Computer platform. They loaded the map base generated by Tarrant County & Harris County Team members and overlayed ESN boundaries for routing purposes. This map data represented graphical equivalents of the traditional MSAG used within the current wireline routing scheme. The SCC SR/ALI component provided call setup instructions to the selective routing tandem in the form of an ESN. Additionally, the geospatial version of automatic location information (ALI) was provided to the PSAP's from this same product.

SR/ALI, utilizing LDT information, served as the dynamic call routing component of the demonstration. This was accomplished by plotting the latitude/longitude data in a pre-

defined polygon, commonly known as an Emergency Service Number (ESN) area having a unique routing code (ESN) assigned thereto. This platform may also serve as the PSAP's gateway to the wireline ALI database, thereby providing a single point of electronic query for the PSAP's.

SOUTHWESTERN BELL AND LUCENT PARTICIPATION:

SBC was extremely active in providing project support via numerous avenues. Key areas included but were not limited to:

- Use of an appropriate central office switch;
- DigiLine connectivity for the LDT provider, PSAPs and others as required;
- SS7 message trunking from the wireless carrier to the selective router;
- Translations and technical support for the wireless carrier;
- Facilities usage for SCC's hardware and software;
- Technical engineering and logistical support for the SCC interface;
- Project coordination support;
- Participation in a limited number of meetings for project coordination and documentation; and,
- Participation in the coordination of media and public relations

NORTEL'S PARTICIPATION:

NORTEL's installed base of VISIT ENR premises equipment was used in the Harris County PSAP's. Numerous additional services were provided by NORTEL including:

- Facilitation of Wireless Integration Team Meetings;
- Consulting services for computer telephony and overall system integration;
- Software modifications and enhancements to enable VISIT ENR to interface with the SCC SR/ALI application;
- Integration of mapping software into VISIT ENR;
- Plotting of geospatial data in the form of cell site RF coverage areas and latitude/longitude information supplied by the Harris County switches;
- Enhancements to allow for passage of calling and called party data;
- Programming and developmental services;
- Supplemental Project Management; and,
- Documentation support and video production support services for permanent record and publication of project results.

TARRANT COUNTY 9-1-1 DISTRICT'S PARTICIPATION:

Tarrant County 9-1-1 District provided expertise relative to quality control of the base map used in the Texas Wireless Integration project for Phase II dynamic call routing and map display purposes. To this end, a sub-contract was established between Greater Harris County 9-1-1 and SDR, Keith Cunningham, Principal, which was supervised by Beth Ozanich of Tarrant County 9-1-1. Ozanich worked cooperatively with GHC staff to transfer knowledge of the procedures carried out by SDR to GHC for later application.

Tarrant County 9-1-1 generated documentation of base map requirements for accurate wireless plotting under the arrangement described above resulting in the preparation of information pertaining to retro-rectification of commercially available base maps generated from Enhanced Tiger data, which are frequently used throughout Texas.

Tarrant County 9-1-1 District staff also provided documentation design, organization and oversight, project reporting and management. Ozanich served as the project management team contact point for production of the video documentation produced by NORTEL.

GTE TELOPS PARTICIPATION:

GTE Telops provided Team coordination for the location determination technology (LDT) analysis portion of the demonstration, as well as coordination of GTE Labs validation and subsequent documentation. Additionally, GTE Telops provided information documenting the various technologies employed to produce LDT collected during a previous internal study for inclusion in the final WIP report.

GTE LABS PARTICIPATION:

GTE Labs provided technical evaluation of the data generated as part of the Phase II test. They assisted in designing and conducting the technical test and prepared a report on the adequacy of the data generated in meeting the criteria set out by the FCC in Order 94-102 for locational accuracy (125RMS).

Phase II Description

Test participants (technicians) placed 2-1-1 test calls from the designated geographic area identified for the project. The wireless carrier translated the dialed digits to the pseudo ANI based on the origination site of the cell site. The wireless carrier then delivered the call via dedicated facilities to the SBC selective routing tandem. The tandem accepted the 2-1-1 test call from the wireless carrier and queried SCC's SR/ALI for call setup instructions.

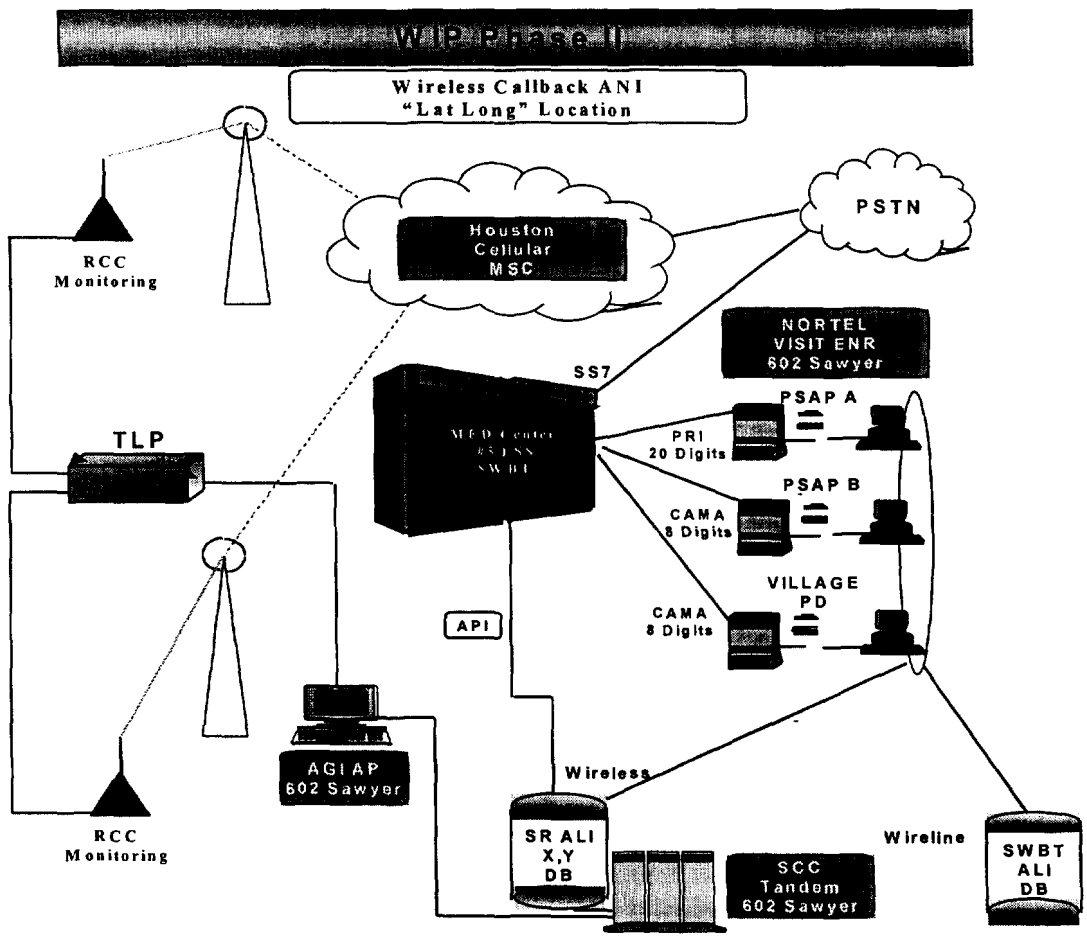
Concurrently, the LDT provider acquired a geospatial fix for the 2-1-1 caller via their time distance of arrival (TDOA) technology. The location information was passed to SCC's SR/ALI host computer via a dedicated data facility provided by SBC. The caller's mobile number was included for call identification purposes.

Dynamic Call Routing (DCR) was supplied via SCC's interface to the SBC selective routing tandem. DCR allowed for the selective routing tandem to accept call setup instructions from an application outside of the normal 9-1-1 call setup tables inherent to the 5E switch. SCC's SR/ALI accepted the mobile number and (x,y) coordinate information related to the in-progress call from the LDT provider. SCC compared the location of the test caller to the geopolitical jurisdictional boundaries in the geospatial data base and determined the appropriate PSAP for call delivery. The system then created a dynamic call record, including an emergency service number (ESN) which was used by the tandem for call setup. The application also dynamically created a modified ALI record. This record was provided back to the PSAP when the ALI query was received.

The tandem routed the call to the appropriate Harris County test PSAP. The PSAPs utilized NORTEL's VISIT ENR premises equipment and accepted test calls as presented with ten digit ANI. The PSAP then queried SCC's SR/ALI System via an SBC provided data connection. VISIT ENR determined the appropriate ALI data base to query based on the caller's NXX. The ALI response record contained coordinates (latitude/longitude) along with other specific data elements used by the PSAP to graphically display a map depicting the caller's location and associated resolution (accuracy) information.

In the event that the location information was not present or the system was unable to create the dynamic call setup instructions in a timely manner, the call was routed based on the pseudo-ANI. The subsequent ALI query may be used by the call-taker for redirection of the 2-1-1 call.

Test Architecture



PARTICIPANT REPORTS

TruePosition - Associated Group, Inc.
Louis A. Stilp

The time-difference-of-arrival (TDOA) technology used in the TruePosition Wireless Location System is the same accurate technology used in the Global Positioning System and in many sophisticated radar systems. Time-difference-of-arrival relies on a very precise timing of the signals sent by a mobile phone during the start of a 9-1-1 call. The signals travel at the speed of light, and TruePosition can time the signals using techniques accurate to billionths of a second.

There are over 25,000 cell sites in the U.S. today, but wireless communications networks are designed so that a mobile telephone uses only one cell site at a time. These systems are very efficient for placing calls, but it means that current receivers are not capable of determining an emergency caller's exact location.

TruePosition relies on advanced location receivers added to existing cell sites. The signals transmitted by a cellular phone during a 9-1-1 call are collected by the TruePosition receivers at three to eight different cell sites. The data collected by these receivers are then combined to calculate an emergency caller's location. Typically, the location can be displayed on an emergency dispatcher's computer map terminal before the call is even answered.

The use of time-difference-of-arrival technology means that none of the 42 million wireless telephones in use today in the U.S. need to be changed. Technology upgrades are needed only at cell sites, and users of wireless networks can keep the mobile telephones they already own and still obtain the benefits of TruePosition.

TruePosition augments an enhanced 911 system by linking precise location data with delivery of the wireless voice call. Here's how it works:

The wireless Mobile Switching Center (MSC) is configured to provide caller Automatic Number Identification (ANI) and cell site identity to the 911 tandem switch. Each cell site and sector is assigned a unique 10-digit identity number (pseudo-ANI). When routing a 9-1-1 call to the 911 tandem, a Feature Group D trunk transmits the caller's ANI in one 10-digit field and the cell site's pseudo-ANI in a second 10-digit field.